CO_2 Capture and Storage Global Developments

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Introduction

- Review the status of CCS internationally
- Current CCS project status worldwide
  - Highlight recent developments
- Discuss challenges ahead

International Policy

- The main international frameworks covering CCS are:
  - The Law of the Sea (UNCLOS)
    - London Convention
      - OSPAR Convention (North West Europe)
  - Climate Change Framework
    - Kyoto Protocol
  - Considerable progress has been made in recent years

International Acceptance

- London Convention
  - Meetings of Scientific Group and Legal Working Group held in April 2006
  - Technical Working Group meeting recommended that:
    - CCS is a waste management option to be considered by Contracting Parties' in their approaches to mitigating greenhouse gas emissions
  - Legal Working Group agreed to amend Annex 1 of Protocol to the Convention to allow CO_2 to be included under wastes that can be disposed of (Paragraph 1.8)
    - Only in sub sea geological structures,
    - The waste is overwhelmingly of carbon dioxide,
    - No wastes or other matter are added.
  - Proposals from Working groups submitted to first Statutory Meeting of the Protocol Parties
    - 30 October – November 3, 2006
  - Amendment to London Convention accepted
    - CCS in sub sea geological storage structures now legal under London Convention

Role for CCS in Mitigating Climate Change?

"No single technology option will provide all of the emission reductions needed to achieve stabilization, but a portfolio of mitigation measures will be needed."

"CCS has the potential to reduce overall mitigation costs and increase flexibility in achieving greenhouse gas emission reductions."

"Widespread application of CCS would depend on (…) diffusion and transfer of the technology to developing countries and their capacity to apply the technology"

"Economic potential of CCS would amount to 220 - 2,200 $GtCO_2$ (60 - 600 GtC) cumulatively"

" would mean that CCS contributes 15 to 55% to the cumulative mitigation effort worldwide until 2100, averaged over a range of baseline scenarios."

IPCC SRCCS Summary for Policy Makers

Geological Storage

"Available evidence suggests that worldwide, it is likely that there is a technical potential of at least about 2,000 $GtCO_2$ (545 GtC) of storage capacity in geological formations"

"It is likely that the technical potential for geological storage is sufficient to cover the high end of the economic potential range, but for specific regions, this may not be true."

IPCC SRCCS Summary for Policy Makers

Local Risks

CO_2 pipelines:

"The local risks associated with CO_2 pipeline transport could be similar to or lower than those posed by hydrocarbon pipelines in operation."

Geological storage: with:

"appropriate site selection …, a monitoring program to detect problems …, a regulatory system, appropriate use of remediation methods to stop or control CO_2 releases if they arise"

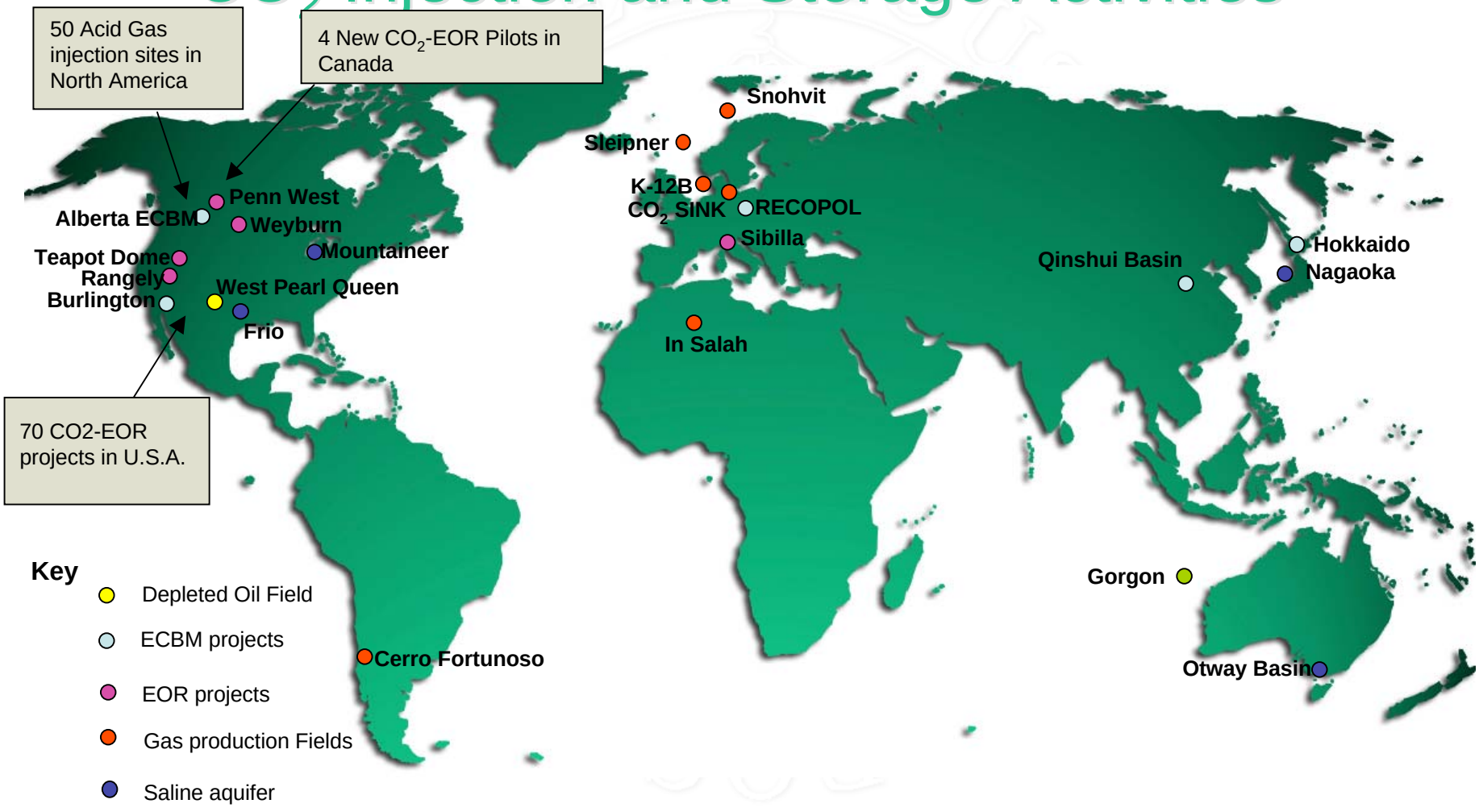
"The local health, safety and environment risks of geological storage would be comparable to risks of current activities - natural gas storage, EOR, deep underground acid gas disposal."

IPCC SRCCS Summary for Policy Makers

CCS Project Proliferation

- Commercial activity primarily in oil and gas sector
- Number of research projects injecting/capturing CO_2 increasing
  - Expect up to 10 more in USA in coming years as part of Regional Partnership programmes
- Now seeing pre-commercial/commercial developments for power sector projects
  - Australia, Canada, Germany, Norway, UK & USA
  - No direct financial incentives

CO_2 Injection and Storage Activities



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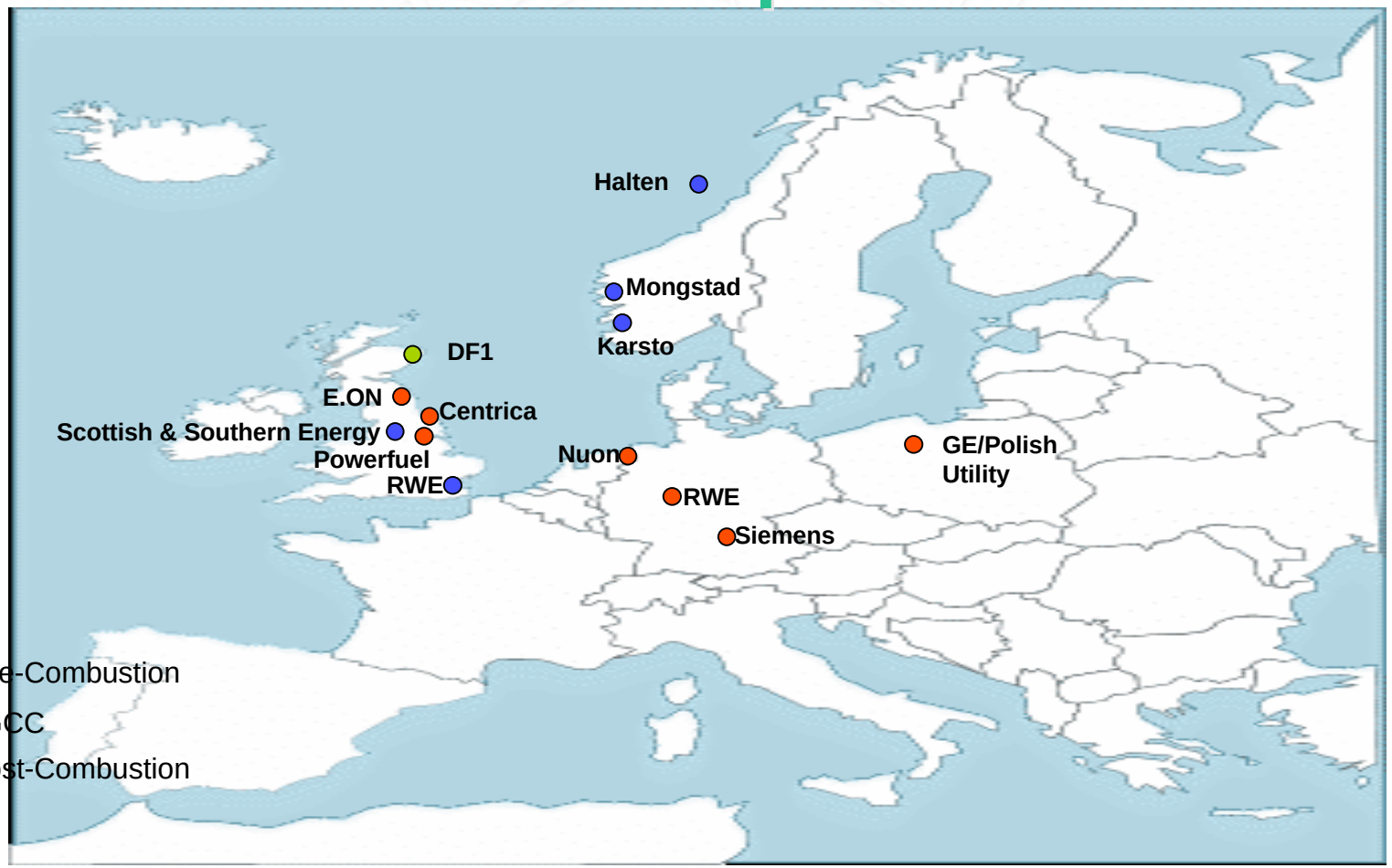
Proposed Integrated CCS Projects

Proposed Integrated CCS Projects- Europe



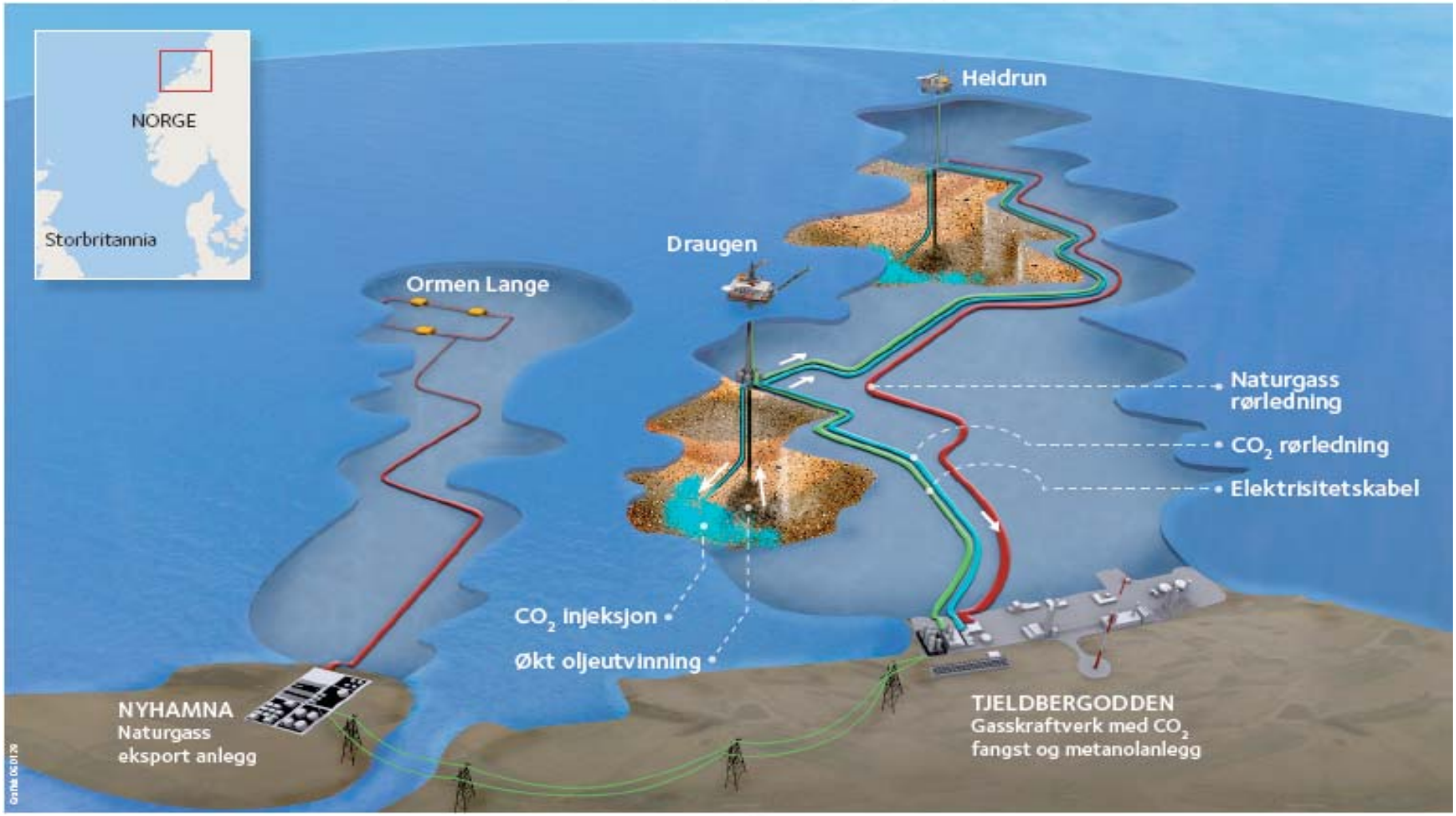
Key

- Pre-Combustion
- IGCC
- Post-Combustion

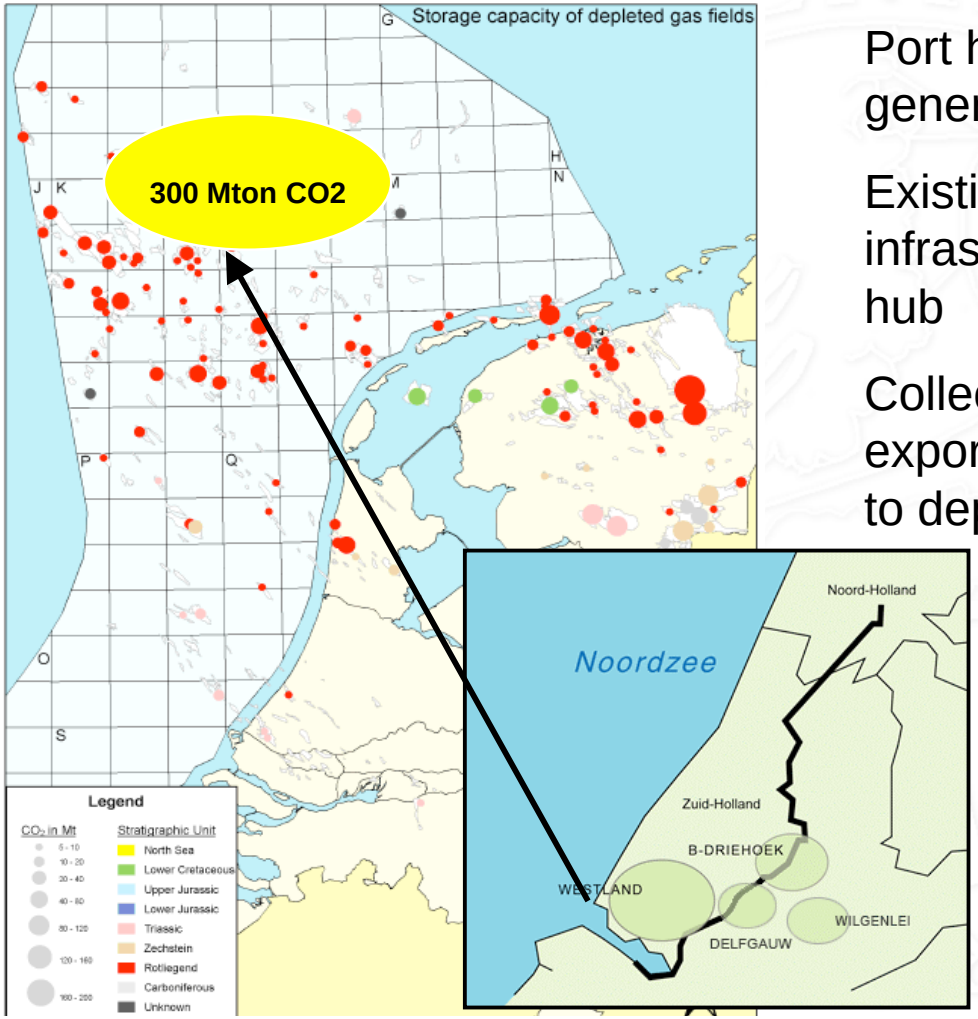
Developing Country Activities

- China
  - EC/UK funded nZEC project
  - EC funded COACH project
  - EC funded GEOCAPACITY
- India
  - IEA GHG/DEFRA funded source/store matching study
  - US DOE funded Basalt study
  - Indian funded CO_2 capture test facility proposed
- Asia Pacific Partnership
  - Australian Government $6m programme to support research on CCS developments in China and India

Norwegian Approach



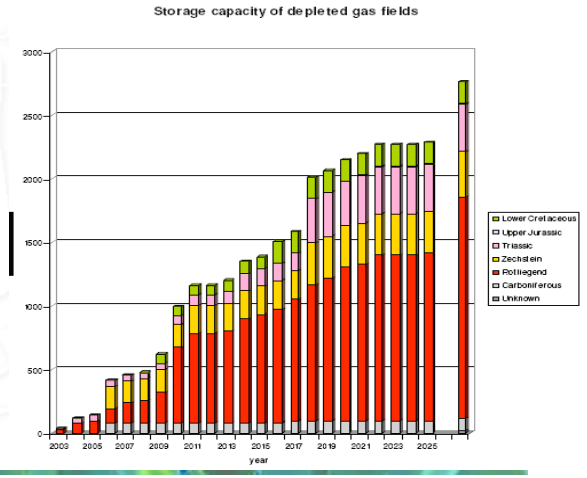
Rotterdam Energy Port and CO_2 Hub

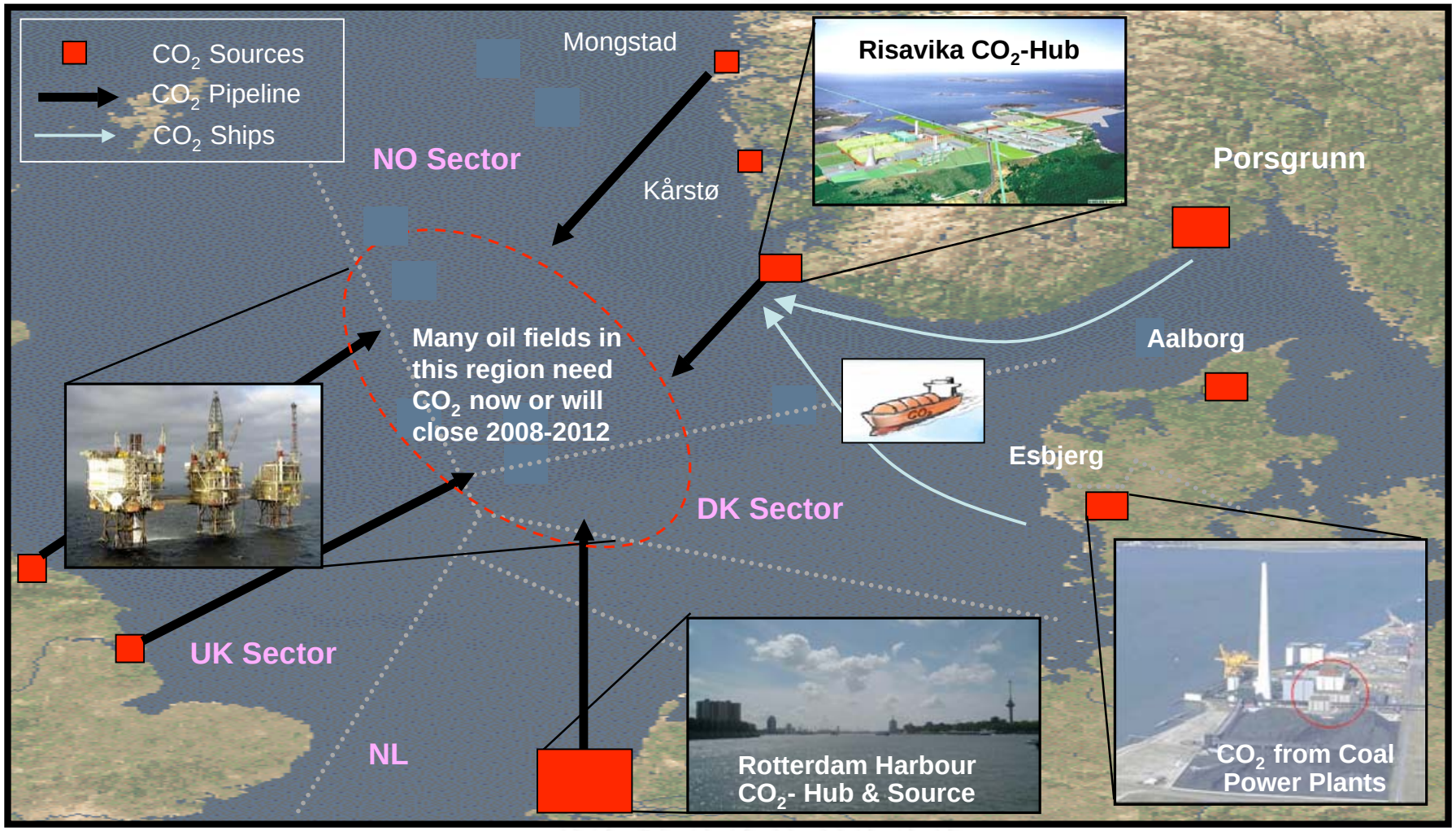


Port has existing and planned power generation capacity

Existing oil and gas pipeline infrastructure as an energy import hub

Collect CO_2 from Netherlands and export through existing infrastructure to depleted gas fields





Bron: CO_2-Global (www.co2-global.com)

Challenges Ahead

- Issues that need to be addressed
  - Safety/permanence
  - Developed regulatory system
  - Market for CCS
  - Public Awareness/Education

Safety/Permanence

- For a CCS operation we cannot say there will be never be leakage
- Industry statistics show there will be fugitive emissions from pipelines and surface facilities
  - Low level and intermittent
  - Can quantify such emissions
- These emissions are distinct from the storage formation
  - If they occur these will be very low level (seepage) and occur over long time periods
  - Likely to cause local environmental impacts

Safety/Permanence

- Need to engineer for zero leakage from the storage formation
- 5 component plan:
  - Detailed site characterisation
  - Reservoir simulation
  - Risk assessment
  - Monitoring programme
  - Remediation programme

Summary of Monitoring Experience

- No firm evidence from any of the large scale projects that leakage is occurring
  - Weyburn (~5 years), Sleipner (~10 years), Rangeley (~25 years)
- Only one project has identified any surface seepage
  - There are doubts about the data
- Monitoring lifetimes are short <25 years
- Cannot quantify seepage rates

Regulatory Developments

- Need for regulatory systems essential to implement projects in near term
- Quicker to amends existing regulations than develop new ones
  - European Commission
    - Inclusion of CCS undertake existing environmental and waste pollution directives
  - European Nations
    - Netherlands - adapted existing laws
    - UK - regulatory task force established
    - Norway - permitting CCS under existing laws
  - USA
    - Adapting UIC programme legislation
  - Australia
    - State and Federal Governments involved
    - Gorgon review under way

CCS Market Drivers

- Currently high oil and gas prices will drive some CO_2 injection projects
  - Low incremental cost for storage
    - Sleipner, In-Salah, Snohvit
  - Economic incentive through increased hydrocarbon production
    - Weyburn, K-12B
- Norwegian situation
  - Tax incentives for offshore emission reduction driving project development

CCS Market Creation

- Long term CO_2 market needs to be created
- Emissions Trading Scheme
  - European system immature
  - Current price will not finance CCS projects (€0.9/t CO_2)
  - Current volatility will not encourage long term investment (Range €0.6 to 29/t CO_2)
- Need to drive down cost of CCS
  - 20-40% cost reductions achievable through replication
- In short term projects may need government support
- Longer term a stable trading market establishes itself
  - CO_2 supply/storage infrastructure needs to develop

Norwegian Initiative

- New initiative in Norway to create a CO_2 supply infrastructure
  - Part public sector/part private sector enterprise
  - Establish a CO_2 supply infrastructure for Norway to realise it CO_2-EOR potential
  - Leave behind a supply infrastructure that can then be used for CO_2 storage
  - Announced in Autumn 2006

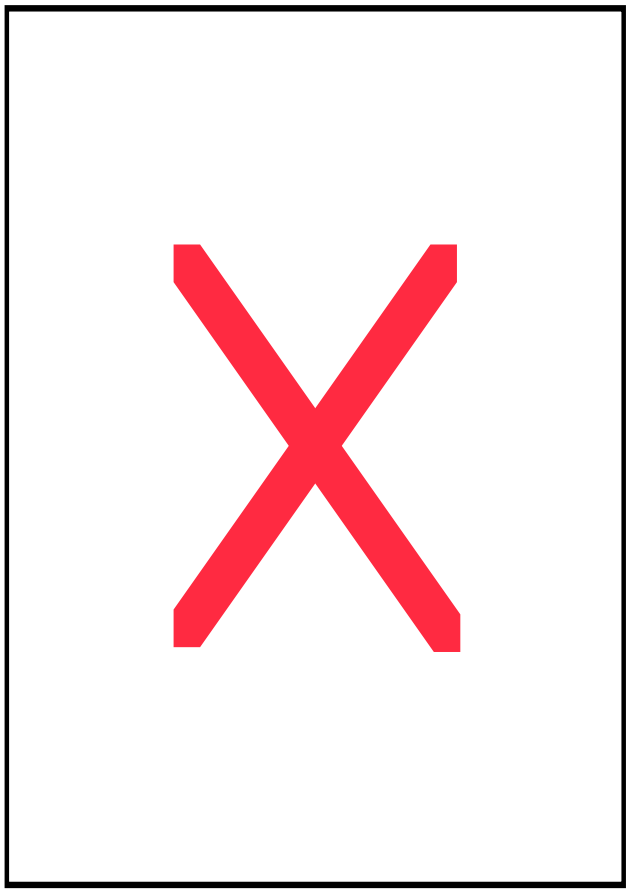
Public Awareness/Education

- Public awareness on CCS is currently limited
- Need to build public awareness to ensure projects do not meet public resistance
- Need to urgently start an education programme
  - Open and transparent
  - Happening at pilot project scale in some countries
    - Australia, Europe, Canada and USA
  - Need more concerted engagement programmes
    - CATO programme and Japan
  - Need more demonstration projects with public engagement
    - In-Salah
  - Need to be aware that local issues could dominate in planning reviews

Need to Break Taboo's

Lake Nyos

- Detailed study demonstrated that geologically Lake Nyos is untypical of a CO_2 storage site
- Cannot use Nyos incident as a reference for possible release from a CO_2 storage site
- Peer reviewed study and paper available



THANK YOU
ANY QUESTIONS?